Augmenting the City

The Design of a Context-Aware Mobile Web Site

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Augmenting the City: The Design of a Context-Aware Mobile Web Site

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Abstract
We present the design of "Just-for-Us" - a context-aware web site for mobile devices augmenting the social experience of the city. Informing design, field studies of social groups' situated social interactions were carried out in a new civic space in Melbourne, Australia followed by paper prototyping and implementation of a functional mobile web site. The produced solution augments the city through web-based access to a digital layer of information about people, places and activities adapted to users' physical and social context and their history of social interactions in the city. The system was evaluated in lab and field, validating the fundamental idea but also identifying a number of shortcomings.

Keywords
Context-Aware Computing, Handheld Devices and Mobile Computing, Web Services, Ethnography.

Project/problem statement
Mobile devices are increasingly being appropriated and used outside the work domain to facilitate people's social life. Mobile phones, and especially SMS texting, have changed the way people communicate, interact in the physical world, and coordinate their social activities [4] [10]. Smart Phones bring access to Internet communities to the mobile user and provide Internet chat and video-based communication capabilities. By embedding networked sensors such as Bluetooth and RFID tags, etc. into the built environment, mobile

Figure 1. Federation Square, Melbourne, Australia

services are emerging that adapt their content to the user's physical and social contexts. For example, mobile dating services exist which alert users when they are in the proximity of a potential partner matching their own pattern of attributes [3]. As another example, swiping electronic membership cards at cafés and music clubs in some Danish cities makes it possible to identify the whereabouts of one's friends [5]. The emergence of systems like these represents a new trend of huge interest to the user experience design community: facilitating sociality in the city through context-aware mobile devices. However, adapting mobile information systems to people's physical and social context is not trivial and further research and practical experience with actual design is needed. Approaching this challenge, we designed and implemented a context-aware mobile website, Just-for-Us, augmenting the city.

Background

- The University of Melbourne, Australia. Interaction Design Group, Department of Information Systems
- Aalborg University, Denmark. Human-Computer Interaction Lab, Department of Computer Science

Process

Designing Just-for-Us involved five major activities:

- Field studies
- Architectural and sociological data analysis
- Paper prototyping iterations
- Implementation of design sketches
- User-based evaluations in the lab and in the field

For the purpose of informing a first pilot system design, we decided to focus on a delimited section of a large city precinct in the city of Melbourne, Australia (figure 1). Federation Square is a new civic structure, opened to the public in October 2002, covering an entire city block, providing the people of Melbourne a mix of attractions and public spaces for socializing including restaurants, cafes, bars, a museum, galleries, cinemas, retail shops and several public forums. Thus, this particular place provided a unique setting for studying people's situated social interactions when out on the town, and inquiring into the user experience of mobile technology augmenting the city.

Inquiring into people's use of Federation Square for socializing, we conducted a series of field studies into the architectural features of the space and of people's situated social interactions there. The architectural field study consisted of a series of field visits to Federation Square by a researcher with architectural training guided by Lynch's [6] and Alexander's [1] methods for city precinct and built environment analysis. It resulted in the collection of 250 digital photographs of physical elements in the built environment annotated with observations of the relationship between architectural elements and the environment, as well as a map of the space annotated with key characteristics (figures 10 and 11). The sociological field study consisted of a series of contextual interviews [2] with established social groups at Federation Square (figure 12). It was guided by a subset of McCullough's typology of everyday situations [7] for classifying peoples social activities when out on the town: eating, drinking, talking, gathering, cruising, belonging, shopping, and attending. The outcome of this amounted to 8 hours of video and approximately 30 pages of written notes. The findings are described in full detail in [8] [9].

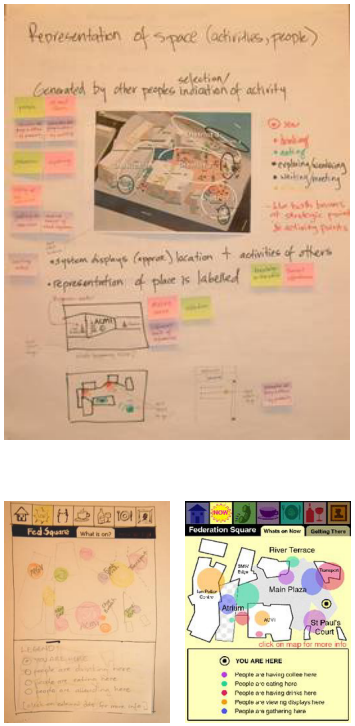

Figure 2. From conceptual design ideas to paper-based mockups and detailed paper prototypes

Three Design Iterations

Following the data analysis, a design team produced a detailed design sketch and a set of specific system requirements for a functional prototype.

The first step in the design process was to develop a series of conceptual design ideas based on insight from our data analysis. The outcome from this design activity was a collection of seven design sketches (figure 2 top) each describing conceptually a specific part of the envisioned mobile web site including general functions, ideas for graphical design and user interaction with clear references back to the empirical data.

On the basis of the conceptual design ideas and inspired by other context-aware mobile information systems, a series of paper-based mockups were then produced (figure 2 bottom left) facilitating a long series of design discussions and leading to an overall concept for the user experience. Based on the paper-based design mockups, more detailed paper prototypes were produced using Adobe Photoshop and screen shots from Microsoft Pocket Internet Explorer (figure 2 bottom right). This forced the design team to work within the graphical limitations of the target device and to use the specific graphical user interface elements available in the target browser. Also, the detailed paper prototypes allowed the designers to discuss some of the more dynamic interaction issues such as navigation structure and information push.

After the final paper prototype had been agreed upon, this design was implemented as a fully functional prototype using PHP and JavaScript.

Solution

The Just-for-Us prototype was implemented as a server-side web application to be accessed through Microsoft Pocket Internet Explorer in full screen mode.

For the prototype, we used a series of HP iPAQ h5550's connected to the Internet through WLAN or GPRS. The user experience design of the Just-for-Us mobile web site is based on four overall ideas emerging from the empirical field studies:

- Making the invisible visible
- Supporting ad-hoc text-based communication
- Indexing content to history and context
- Representing activities within proximity

Making the invisible visible

One of the key findings from the field studies was that the physical space of Federation Square is divided into four districts each with distinct features and landmarks. Like many other places, the space has significant focal structures but it is difficult to find out what is going on behind the facades. This informed the design of the "home screen" of Just-for-Us, making the invisible visible and indexing to the built environment.

When entering a district at Federation Square, a "home screen" is pushed to the device with information corresponding to the district where the user is located (figure 3). The home screen consists of four elements; 1) the name of the district, 2) textual descriptions of places in that district, 3) a 360º annotated panoramic view of the district and surrounding city, and 4) an activity meter showing the current patronage and primary activity at a selected place. The annotations on the panoramic photograph show what is located behind the physical structures surrounding the user, thus making the invisible visible through a form of indirect augmented reality. Clicking on an annotation displays a short description of that place and a list of what's currently happening there.

Figure 3. Home screen: augmenting the user's built surroundings

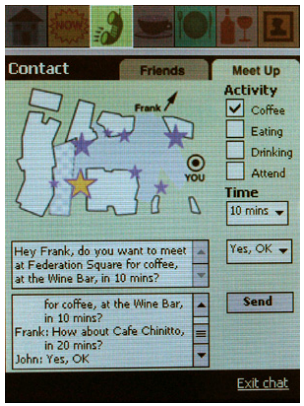

Figure 4. Contact screen: shared objects (map, activity, time) and chat window

Supporting ad-hoc text–based communication
Another central finding from the field studies was that people typically coordinate meeting up with their friends in a highly ad-hoc manner. Typically, this involves a lot of communication negotiating who, why, where and when to meet. Activities depend on who you are meeting and what the others want to do. Places to go to depend on what activity you want to do and your shared history of going out. Places to meet depend on people's physical familiarity with a place, how long you have to wait, and the presence and activity of others. When to meet depends on people's physical distance from potential meeting places, who you are meeting up with, and why you are meeting up. These findings informed the design of the "contact" screen of Just-for-Us, providing a text-based communication channel to one's friends with a set of shared representations for negotiating a rendezvous. When the user selects the "contact" option on the top menu bar of the screen, the system displays a list of friends divided into three parts: 1) friends who are online and within proximity; 2) friends who are online but further away; and 3) friends who are offline. If two or more friends are currently together (within close proximity of each other) they are displayed as a group. When the user selects a friend or a group of friends, an Internet chat session is established (figure 4). Apart from supporting free text input, text can also be generated by interacting with the map, activity checkboxes and a time drop-down menu, such as "Hey Frank, do you want to meet at Federation Square for coffee at The Wine Bar in 10 minutes?". When an automatically generated text message is sent, it causes the selected place, activity and time to be synchronized among the participants in the chat, who can now modify the original suggestion, causing a counter suggestion such as "How about a drink at Transport Hotel in 25 minutes?".

Indexing content to history and context
Another finding from the empirical studies, which had impact on the design of Just-for-Us, was that places and spaces are dynamic and that setting matters immensely for the quality of socializing – especially in relation to its physicality, the presence and activities of other people and convenience in terms of proximity. On the basis of these findings, Just-for-Us attempts to support the ongoing negotiation of where to go by indexing to the social group's shared knowledge of familiar places and providing information for the group to be able to size-up the situation before committing to entering a place. When the user clicks on one of the four activity-icons at the top of the screen (coffee, food, drinks or cultural events), the system presents a list of places supporting this activity (figure 5).
The list is sorted on the basis of the systems knowledge about user's familiar places (history of prior visits), current physical and social setting (where the user is and who he or she is with) and the current weather conditions. From the list of recommendations, the user can access more information about a place such as menus or programs. If the user is physically present at a place supporting the selected activity, Just-for-Us takes the user directly to detailed information (e.g. menus for that place).

Representing activities within proximity
A fourth finding from the field studies of socialising at Federation Square, which had impact on the design of Just-for-Us, was that people make sense of a place through the social affordances provided by other people; where they are and what they are doing there.

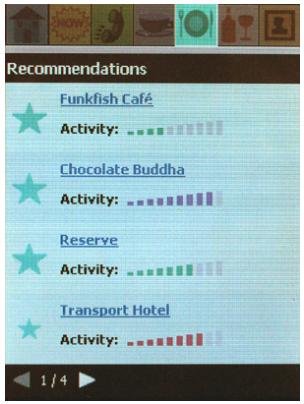

Figure 5. Recommendations screen: ranked list of places to go for food

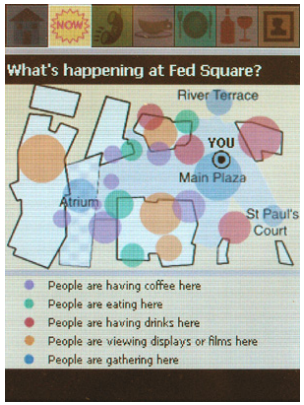

Figure 6. Now screen: showing clustering and activities of people

People often use this information as important cues for where to go and what to do themselves. It also accommodates people's desire for interaction by proximity between their own social group and others. This finding informed the design of the "now" screen. When the user clicks on the "now" icon on the main menu, the system displays a small map of the user's immediate surroundings with superimposed, dynamically updated coloured circles indicating the clustering and activities of people within proximity (figure 6). The radius of the circle indicates the number of people at a place while the colour represents their prevalent activity (e.g. "having coffee", "having a drink", "eating" or "attending a cultural event") using the system's general colour coding of these activities. The map also shows the user's (approximate) location. Clicking on a coloured circle takes the user to more information about that place: menus, programmes, etc., and directions on how to get there.

Results

For the purpose of studying the user experience of the Just-for-Us prototype in the hands of prospective user groups in a realistic environment, we developed a mobile "usability laboratory" which we could take with us into the field. In order to optimize the number of evaluations within our time constraints, the first half were done in the field and the second half in the lab. The evaluation included 20 established social groups of two people familiar with Federation Square prompted to use different parts of the system for 1 hour while thinking aloud and responding to interview questions. The use of the system was recorded on digital video by means of a newly developed, state-of-the-art mobile audio/video recording studio developed as part of the project (figure 7). This facility allows a miniature wireless camera to be attached to the mobile device (figure 8), capturing a close-up image of the screen. The video signal from the wireless camera is sent to a receiver in the bag carried by the test monitor where it is mixed on the fly with a third-person view of the users (figure 9) allowing high-quality data collection as well as unobstructed user interaction (figure 13).

Outcomes from Evaluation

Observing people's use of the prototype provided rich data on the use and usability of the design. First of all, the user study showed that people could easily operate the mobile web site, find what they were looking for and understand the presented information and functionality. They found the design of the mobile web site attractive, streamlined and professional looking, and trusted its content to be true.

On a general level, most users reported that providing a digital layer of information augmenting the city on their mobile device was "very cool", "useful" and "fun". As a part of this people were fascinated that the system *knew* their current physical location, who they were with, and where other people in the civic space were currently gathering. They were also fascinated by the ability to access information about the places around them on their mobile device.

Adapting information and functionality to their physical location was generally found to be intriguing and very useful – although some users at first encounter reported this to be "a little bit freaky" and had to get used to this way of interacting with a web system. Visually augmenting the surroundings was generally found to be an interesting, flexible and easy way to facilitate exploration of what's around you. Representing other people and their activities was found to be of huge value for getting an overview and

Figure 7. The mobile audio/video recording studio

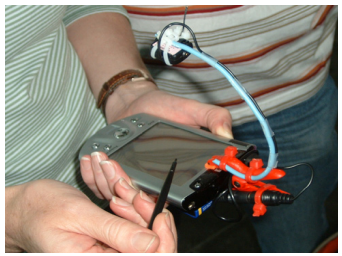

Figure 8. Wireless micro camera mounted on mobile device

Figure 9. Video recording of use in the field: overall view of participants, interviewer and physical surroundings with insert of mobile device interface

informing discussions of where to go and what to do.
The fundamental idea behind indexing information and functionality on a mobile device to the user's context is to facilitate a reduction of the information needed to be presented explicitly to the user and relying on implicitly present information instead [9]. In relation to the use of this principle in Just-for-Us, the user study showed that people were generally highly capable of making sense of sometimes very reduced and fragmented information – depending on the contextual factors adapted to, and provided that the right clues for the interpretation of information were given.
On the negative side, the user study also revealed a series of limitations. First of all, people were sometimes surprised when the system adapted information to their current location, social context and history of visits. They were not used to web sites operating in this way, and were at times uncertain of how to control it. As an extension of this, the users generally expressed that they would like to have more control over their profile in the system and be able to modify their history of visits for privacy. While people generally liked the idea of reducing information on the basis of their physical location, social group and history of socializing in the city, the present solution sometimes turned out to be *too* minimalistic and lacking the necessary clues for fast and accurate interpretation.
A final problem was accuracy of presented information. While the design team had tried hard to make sure that the system was populated with correct and updated information, most users noticed when this was not the case – for example when places had shut down or temporary structures had been put up. While people were able to distract from this lack of accuracy, it *was* perceived as confusing and weakened the system's credibility.

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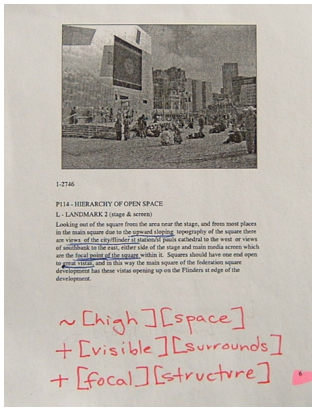

Figure 10. Coding of significant architectural features at Federation Square, inspired by Alexander [1]

Figure 11. Map of Federation Square city precinct with annotated codes for districts, landmarks and other identified significant architectural features, inspired by Lynch [6]

Figure 12. Contextual interview at Federation Square

Figure 13. Evaluating Just-for-Us in the field: researcher operating mobile AV recording studio (left) and researcher conducting contextual interview with participants (right). Ensuring high-quality sound, users and interviewer are wearing directional wireless microphones transmitting to the test monitor's bag. The mixed video and sound is recorded digitally on a 100GB AV recorder